

**Atmospheric Dispersion Modelling
Liaison Committee Report: ADMLC-R7**

January 2013

INCLUDING

**Ingress of External Contaminants into Buildings
– A Review**

A review of urban dispersion modelling

PREFACE

In 1977 a meeting of representatives of government departments, utilities and research organisations was held to discuss methods of calculation of atmospheric dispersion for radioactive releases. Those present agreed on the need for a review of recent developments in atmospheric dispersion modelling, and a Working Group was formed. Those present at the meeting formed an informal Steering Committee that subsequently became the UK Atmospheric Dispersion Modelling Liaison Committee. That Committee operated for a number of years. Members of the Working Group worked voluntarily and produced a series of reports. A workshop on dispersion at low wind speeds was also held, but its proceedings were never published.

The Committee has been reorganised and has adopted terms of reference. The organisations represented on the Committee, and the terms of reference adopted, are given in this report. The organisations represented on the Committee pay an annual subscription. The money thus raised is used to fund reviews on topics agreed by the Committee, and to support in part its secretariat, provided by Health Protection Agency (HPA). The new arrangements came into place for the start of the 1995/96 financial year. This report describes the most recent activities of the Committee. These included a review of the processes governing the ingress of external contaminants into buildings and a review of urban dispersion modelling. The technical specifications for the contracts are given in this report, and the contract reports are attached as annexes to this report. Previous studies funded by the Committee are described in its earlier reports.

The Committee intends to place further contracts in future years and would like to hear from those interested in tendering for such contracts. They should contact the Secretary:

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1 ORGANISATIONS REPRESENTED ON THE COMMITTEE

The organisations on the committee at the time of publication of this report are:

AMEC

Atomic Weapons Establishment, Aldermaston

Defence Science and Technology Laboratory

Department for Environment Food and Rural Affairs (DEFRA)

Department of Energy and Climate Change (DECC)

Environment Agency

Food Standards Agency

Health and Safety Executive

Hazardous Installations Directorate

Office for Nuclear Regulation

Health and Safety Laboratory

Health Protection Agency

Home Office

Meteorological Office

Nuclear Department, HMS Sultan

Scottish Environment Protection Agency

Shell Global Solutions

The present Chairman is Dr Matthew Hort of the Met Office and the Secretariat is provided by the HPA.

2 TERMS OF REFERENCE

The terms of reference of the committee are:

Areas of technical interest

1. ADMLC's main aim is to review current understanding of atmospheric dispersion and related phenomena for application primarily in authorisation or licensing of discharges to atmosphere resulting from industrial, commercial or institutional sites. ADMLC is primarily concerned with dispersion from a particular regulated site or from discrete sources, and will not normally consider work in the following areas: traffic pollution, acid rain and ozone.
2. ADMLC is concerned both with releases under controlled conditions occurring at a constant rate over long periods, and with releases over shorter periods such as accidents or controlled situations where the release rate varies.
3. ADMLC is concerned with modelling dispersion at all scales, including on-site and within buildings.

Organisations and outputs

4. The Committee shall consist of representatives of Government Departments, Government Agencies and organisations with an interest in modelling dispersion of material for the situations identified above. Each organisation represented on the Committee shall pay an annual membership fee.
5. ADMLC believes that it can be most effective by limiting its membership to about 25 organisations. New organisations will only be admitted to membership of ADMLC if the majority of existing members agree to their membership.
6. ADMLC aims to review, collate, interpret and encourage research into applied dispersion modelling problems. It does not endorse particular brands or suppliers of commercial models. However, it is concerned to ensure that users for industrial applications are aware of what is available, how it can be applied to particular problems and of the uncertainties in the results.
7. The Committee will commission work on selected topics. These should be selected following discussion and provisional agreement at meetings of the Committee, followed by confirmation after the meeting. It will produce reports describing current knowledge on the topics. These may be reports from contractors chosen by the committee or may be based on the outcome of conferences or workshops organised on behalf of the committee. The money raised from membership fees will be used to fund contractors, organise workshops and report on their outcome, and any other matters which the Committee may decide.

3 WORK FUNDED DURING THE YEAR

3.1 Ingress of External Contaminants into Buildings – A Review

As pollutants are dispersed in the atmosphere by wind advection and diffusion they may impact on buildings and infiltrate into internal spaces. This infiltration may arise passively through fissures in building materials or through open windows or by mechanical means through forced ventilation systems. As a consequence air and surfaces within the building may become contaminated.

ADMLC is interested in reviewing models and methods for estimating concentrations of pollutants inside buildings, in air and on internal surfaces, that arise as a consequence of concentrations in air outside the building. ADMLC previously funded work in this area in 1996 <http://admlc.org.uk/documents/r302.pdf> and is now interested in reviewing developments since this time. The committee is aware of work being carried out in this area by Centre for the Protection of National Infrastructure (CPNI), Dstl and Home Office.

It is not uncommon for indoor concentrations in air to be estimated using simple ratios where the air concentration indoors is assumed to be in equilibrium with the air outside. This may be a reasonable assumption for some situations but is likely to depend on the type of building and its construction, ventilation mechanisms and the duration of the release. This approach also often assumes that the air concentration is uniform around the building which in many situations is unlikely to be true. For example modelling dispersion in street canyons has shown that high pressures may be exerted at some locations on building surfaces that may lead to high indoor concentrations.

For this review ADMLC are primarily interested in releases of hazardous materials over relatively short periods of time rather than continuous releases. The review should therefore concentrate on scenarios where pollutants outside the building are only present for short periods of time (up to 24 hours) and from a single source. For such scenarios details of the time dependence of the build-up and decay of pollutant levels indoors and the key factors affecting these changes are of particular interest. However, the possibility of developing some rules of thumb to estimate levels of air concentrations indoors should also be investigated

Once pollutants have penetrated a building they are then likely to be dispersed throughout the building at various rates and to deposit on internal surfaces. Future resuspension may also give rise to an inhalation hazard.

The review should consider a range of models, their availability, input data requirements, ease of use and general strengths and weaknesses. Key parameters in such assessments should be identified and their importance, in

terms of sensitivity of results, should be considered. Some specific parameters to consider include:

- Outdoor air concentration at the building surface as a function of location and time.
- Meteorological conditions outdoors (eg wind speed, rainfall rate, temperature)
- Environmental conditions inside the building (eg humidity, temperature)
- Pressure over building surface as a function of location and time
- Building materials
- Ventilation rates
- Air exchange rates (indoor/outdoor, room to room)
- Pollutant type, particle size, reactivity
- Values of typical equilibrium concentration ratios between indoors and outdoors and when it is appropriate to apply these.

The report on this work is published as [ADMLC/2012/1](#).

3.2 A review of urban dispersion modelling

Our understanding of urban dispersion modelling and the techniques for modelling atmospheric dispersion in urban environments are continually developing and evolving. This review should pull together such understanding and techniques in a manner which clearly demonstrates the current position of urban dispersion modelling and scope for future advances and further work. The review should identify relevant modelling approaches and the relative merits of these different modelling approaches (which could include a set of scenarios on the basis of which the merits of modelling approaches could be gauged).

A literature review should be performed to identify a range of modelling approaches, which should include:

- Network type approaches.

For example a 'street network' approach to dispersion modelling in an urban environment, whereby generic blocks and street intersections are considered (as opposed to a detailed consideration of the streets and buildings in a specific city)

- Parameterised scheme.

Ranging from rules of thumb through simple 'urban' models e.g., just using roughness length to models such as UDM as found in HPAC and ARGOS, QUIC-URB, etc.

- Fast CFD type approaches (only if suitable for use in emergency response e.g. run times of minutes rather than hours)

For all approaches identified consideration should be given to the applicability of the model to different situations. In particular, it would be useful to identify situations where the model works well and where it can not be applied and to identify the 'tipping point' between the two. Focus should be paid to where each approach could be developed further and utilised (e.g. when giving advice regarding public health).

Such a review should only consider dispersion from localised, discreet sources released over relatively short periods (of the order of a few hours or less), in an urban environment, together with appropriate air flow and meteorology. Consideration of the spatial and temporal applicability should be made including the horizontal spatial scales (Street Canyon - 10's m, Neighbourhood - 100's m, City scale 1000's m or greater); the environment (urban and/or suburban); and the vertical extent (ground level and urban canopy and/or entire boundary layer). Further consideration should be made to the type of release, passive and/or releases characterised by buoyancy/momentum.

In addition a qualitative assessment of the 'use-ability' of the model should be undertaken, considering the extent to which the model is user friendly, the data requirements of the model, and accessibility and availability of such models.

This review should focus on the advances in urban dispersion modelling since ADMLC funded a CERC review of dispersion modelling from accidental releases in urban areas in 2002 (http://admlc.org.uk/documents/ADMLC20023_000.pdf).

All of the above should exclude dense gases. The consideration of dense gases would be an extension to the work, as agreed with ADMLC, and would need to consider a different range of models.

The report on this work is published as [ADMLC/2012/2_Text](#) and [ADMLC/2012/2_Fig](#).